

me and begin its melodious song, which much resembles that of our Common Thrush, though inferior in volume. It is, nevertheless, so varied and sweet, that the bird is fairly entitled to be called Hawaii's Nightingale. Mr. D. H. Hitchcock of Hilo told me that many years ago the natives used to bring him the young of this species, which, for the sake of their song, he kept in a cage.

The habit of singing, like a Lark on the wing, possessed by *P. myadestina*, as mentioned by Dr. Stejneger on Mr. Knudsen's authority, was observed by me in both species; but the gentleman last named is incorrect in applying the name of "Uapauau" or "Ou" to the one recently described. The call-note of *P. obscura* is a particularly clear *tweet*, very easily recognized, but it also utters a very remarkable hissing sound when approached. Its flight is slow, and I have frequently shot it as it was flying from tree to tree. It possesses also the very peculiar habit (not noticed by Mr. Knudsen in regard to *P. myadestina*) of shaking its wings when perched on a branch, as if it were shivering with cold or seized with an attack of ague.

The vertical range of this species extends from the lowest forest-zone up to 5000 feet.

XVII.—On the Development of the Feet of *Cypselus melba*.

By L. ZEHNTNER, Cand. Phil., of Bern.*

BEING at present engaged in a study of the development of *Cypselus melba*, especially directed towards the elucidation of its osteological peculiarities, I publish the following interesting results, reserving details for a forthcoming work.

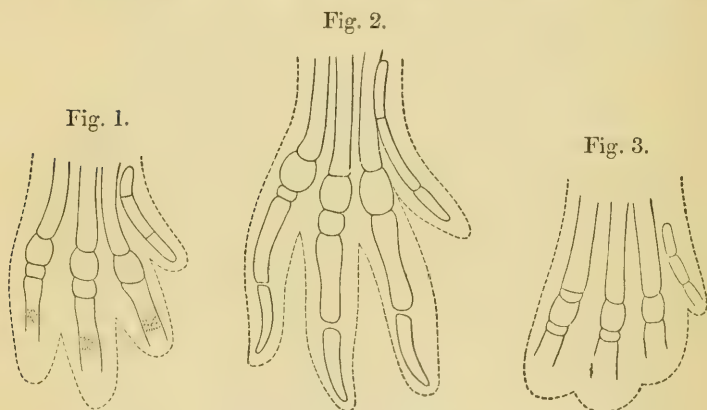
As is well known, the genus *Cypselus* is distinguished from all others by the remarkable reductions in the feet. According to Huxley's law, we find in birds the first toe provided with two, the second with three, the third with four, and the

* Translated (by permission) from a paper in the 'Zoologischer Anzeiger' (No. 319, 1889), entitled "Zur Entwicklung von *Cypselus melba* (Alpensegler)," von L. Zehntner, Cand. Phil. in Bern.

fourth with five phalanges. *Cypselus* and also, according to Selater (P. Z. S. 1865, p. 596) and Forbes (Ibis, 1882, p. 390), *Panyptila* so far differ from this plan that the third and fourth toe have each only three phalanges, while the other Cypselidæ display the normal condition. The genus *Cypselus* thus lacks one phalanx in the third toe and two in the fourth. This reduction has been long known, but never more closely investigated. It was to be expected that embryology would lead to the required explanation, and I therefore undertook the research, the more readily as material was easy to be obtained in Bern, where, on the tower of the cathedral, *Cypselus melba* nests. All the extremities were investigated, and the following is a brief statement of the result:—

In embryos of the 5th and 6th days the skeleton of the foot shows a series of continuous and diverging bars of cartilage, which could only be partially followed into the toes. On the 8th day the appearances are changed. Not only are the three principal divisions of the limb plainly separated, but also to a certain extent the phalanges (see fig. 1, p. 198). *Metatarsale* I. corresponds in position to about the middle of *M.* II., and bears the two phalanges of the first toe. *M.* II., III., and IV. are connected proximally by the distal tarsal row, distally they are free. Their phalanges are plainly recognizable; only the boundary between the last phalanx but one and the one which bears the claw has quite vanished, and is represented by a broad dark band; the distal end of the claw-bearing phalanx is not sharply marked. On the other hand an embryo of ten days shows an appearance (fig. 2) which leaves little to be desired in the way of clearness. I find the first toe with two, the second with three, and the third and fourth with four phalanges each. These numbers are repeated in the adult Pteroclidæ and in most Caprimulgidæ. The difference from the normal bird's foot is now reduced to a single phalanx missing in the fourth toe. I believe I have also found this. Fig. 3 represents a condition which is slightly younger than fig. 1. In the second toe we see one, in the third two, and in the fourth three separate phalanges. After these there follows in each toe (the first is unfortunately injured)

an unjointed cartilaginous streak, which in the next stage (fig. 1) is divided into two phalanges. We have thus also in the fourth toe, at a certain period, the normal number of phalanges, viz. three separate phalanges and a bit of cartilage which corresponds to two phalanges, into which it is later split up. The first phalanx, however, comes into very near relation with *metatarsale* iv., and finally fuses with it, before the claw-bearing phalanx is differentiated. In fig. 1 there is no longer any trace of this phalanx. To return to fig. 2, the first phalanx of the second and third and the



Embryonic feet of *Cypselus melba*.

Fig. 1. Of the eighth day.

2. Of the tenth day.

3. Of a stage rather earlier than in fig. 1.

first (really *second*) of the fourth toe are spherical, with nearly even articular surfaces. The second phalanx of the third toe is very short, broader than long, in fact disk-shaped. This is the case to a greater extent with the second phalanx of the fourth toe. The two terminal phalanges of the three outer toes are much more slender and are all of a similar form.

The question now arises—What is the fate of the second phalanx of the third and fourth toe? In an embryo of the 12th day they are present, and even more conspicuous than on the 10th day. In the third toe the phalanx in question gets more quadrangular in form, in the fourth rounder. The

first phalanx of the three outer toes has lost its spherical form and become cubical. In the ungual phalanges, in which the bending towards the lower side may be seen, the formation of the nail has begun. In nestlings of the 14th day a fusion has commenced. Unfortunately the limbs in this and in older stages, on account of their thickness, do not allow of a sufficiently accurate observation of the process of fusion. Sections, which I have not yet been able to prepare, would probably give the desired result. Yet I believe that I may safely say that in the third toe the second and third phalanges fuse, in the fourth toe the metatarsal and the first phalanx, and the second and third phalanx. At any rate I have observed in several preparations in the upper part of the second phalanx of the third toe a slight transverse groove, probably the last trace of an earlier separated condition. And in the fourth toe the second (that is, actually the *third*) phalanx is in very close relation with the fourth—a fusion has thus commenced. The main fact is, that originally the normal number of phalanges is present, if only for a short time, and that they are afterwards diminished by fusion. The cause of this fusion is possibly that the foot, which serves to catch hold of rocks, walls, beams, &c., requires to be strengthened, and this strengthening is produced by a reduction of the joints.

A further peculiarity of *Cypselus* is the short strong humerus and the disproportionately long hand. In the full-grown wing the length of the hand to that of the arm is as 7 : 5. This remarkable condition is only found in *Cypselus* and in the Trochilidæ. It is interesting to find that this condition is only the result of secondary modifications. I find in a series of stages the following proportions:—

	Humerus.	Radius.	Manus.
8.days' embryo	1	0·86	1·71
10 " "	1	1·12	2·31
12 " "	1	1·12	2·32
14 " "	1	1·12	2·30
16 " "	1	1·12	2·36
Newly hatched young ..	1	1·27	2·43
Chick of three weeks	1	1·42	3·10
Full-grown	1	1·44	3·47

It follows from this table that in an 8 days' chick, contrary to what we find in the adult, first the humerus is longer than the radius, and secondly the arm is longer than the hand. The contrast would be greater in this stage if the length of its skeleton could be taken as representing the length of the hand. But this is impossible owing to the absence of a definite boundary to the skeletal parts distally, and therefore the length of the wing from the radial carpal is taken to represent that of the hand. This stage (that of the 8 days' embryo) lasts but a short time. As the above table shows further on, the proportions alter in an embryo of 10 days; the radius is longer than the humerus and the hand longer than the arm—not strikingly so, but still distinctly. From the 10th day onward to hatching there is no further change in the proportions. All three regions of the wing grow at a nearly equal pace. Afterwards, during the nesting-stage, the forearm and, to a much greater degree, the hand grow out of these proportions. It appears that the nestling, as far as its anterior extremity is concerned, becomes a *Cypselus* after the time of hatching. The humerus, even on the 16th day, has much resemblance to the definite form, while the hand has to grow considerably.

As Jeffries ("On the Claws and Spurs of Birds' Wings," Proc. Bost. Soc. Nat. Hist. vol. xxi. p. 301) has already pointed out, the thumb of *Cypselus* has a claw. This is first formed on the 10th day. In this stage the second finger also has a slender claw, as I have discovered by a suitable preparation. The claw of the pollex remains for some weeks after hatching; the claw of the index finger very rapidly disappears. As regards the carpus and tarsus, I shall treat of this subject in my complete memoir.

XVIII.—*An Attempt to Diagnose the Subclass Coraciiformes and the Orders, Suborders, and Families comprised therein.*

By HENRY SEEBOHM.

THE Coraciiformes differ from all other birds in the arrangement of their deep plantar tendons. There is amongst birds,